PATENT SPECIFICATION

(11) 1 595 804

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(21) Application No. 970/77 (22) Filed 11 Jan. 1977
(23) Complete Specification filed 11 Jan. 1978
(44) Complete Specification published 19 Aug. 1981
(51) INT. CL.^{3} H01H 36/00
(52) Index at acceptance
H1N 330 360 525 616 650 703

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(19) THE PATENT OFFICE LONDON

(54) FLUID-FLOW SENSING DEVICES

(71) We, SMITHS INDUSTRIES LIMITED, a British Company of Cricklewood, London NW2 6JN, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to fluid-flow sensing devices, and especially to fluid-flow sensing devices for use in vehicle ventilation systems.

Vehicle ventilation systems generally include an electrically-operated blower which draws in air from the exterior of the vehicle and forces the air into an interior passenger-carrying compartment of the vehicle to heat, cool or demist that compartment. When the vehicle is travelling at speed however, the use of such a blower may become unnecessary as the ram air flow created by movement of the vehicle may be such as to be capable of forcing air through the ventilation system of the vehicle and into the passenger-carrying compartment in sufficient quantities to carry out the above functions satisfactorily. Under these circumstances, an operative blower is an unnecessary wastage of electrical energy and, if the blower is allowed to operate under such conditions, it may be subjected to excessive loading, with the result that the life of the blower is substantially reduced, or even that the blower is damaged.

It is desirable therefore in order to take full advantage of the ram air flow, that the blower be turned off when the ram air flow reaches a level which is capable of causing sufficient quantities of air to flow through the ventilation system.

It is an object of the present invention therefore to provide a fluid-flow sensing device suitable for use in vehicle ventilation systems.

According to a first aspect of the present invention, there is provided a fluid-flow sensing device including a housing defining a fluid flow passage, a member pivotally mounted in the housing for a limited degree of angular displacement about its pivotal axis in response to fluid flow through the said passage with the extent of each angular displacement varying in accordance with rate of said fluid flow, and means which is arranged to sense a predetermined displacement of said member about its pivotal axis, wherein the said pivotal axis of the member extends substantially through the centre of gravity of that member, and wherein the device includes means to damp said pivotal displacement of the said member.

The device may include resilient means, such as, for example, spring means, that is arranged to urge the said member towards a datum position.

The damping means may comprise a substantially closed chamber into which the said member extends.

The said member may be in the form of a flap having a portion to one side of the pivotal axis which extends into the said passageway and a portion to the other side of the pivotal axis which extends into the said chamber.

The said sensing means may comprise a magnet and a magnetically-operable switching device, such as, for example, a reed-contact unit. The magnet and the switching device may be mounted, within said housing, on opposite sides of the path of travel of a part of said member so that, upon the predetermined pivotal displacement of said member being attained, magnetic flux is diverted through said part to change the state of the switching device. Alternatively, the said member may include the magnet, and said switching device may be mounted on said housing so that, upon the predetermined pivotal displacement of the member being attained, the magnet is moved a sufficient distance relative to the switching device to change the state of the switching device.

According to a second aspect of the present invention, there is provided apparatus for controlling the operation of a blower in a vehicle ventilation system comprising a fluid-flow sensing device in accordance with said first aspect of the present invention, means for coupling the passageway of the said device to a source of ram air flow on the vehicle, and means for controlling a said

blower in accordance with the fluid flow sensed by the said device to inhibit operation of the blower whenever the pivotal displacement of the said member attains the said predetermined value.

According to a third aspect of the present invention, there is provided a vehicle ventilation system comprising a blower for supplying air to the interior of the vehicle, and control apparatus in accordance with the said second aspect of the present invention for controlling the operation of the said blower.

According to a fourth aspect of the present invention, there is provided a vehicle incorporating a vehicle ventilation system in accordance with the said third aspect of the present invention.

Various forms of fluid-flow sensing devices for use in a vehicle ventilation system, in accordance with the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:–

Figure 1 is a cross-sectional side view of one form of fluid-flow sensing device;

Figure 2 is a cross-sectional view of the fluid-flow sensing device shown in Figure 1 along the line II-II of Figure 1;

Figure 3 is a cross-sectional side view of a second form of fluid-flow sensing device;

Figure 4 is a cross-sectional view of the fluid-flow sensing device shown in Figure 3 along the line IV-IV of Figure 3;

Figure 5 is a cross-sectional side view of a third form of fluid-flow sensing device; and

Figure 6 is a cross-sectional view of the fluid-flow sensing device shown in Figure 5 along the line VI-VI of Figure 5.

The various forms of fluid-flow sensing devices are each suitable for use in a vehicle to sense ram air flow caused by movement of the vehicle and are used to control operation of the blower of the vehicle's ventilation system in accordance therewith. Each of the sensing devices generally comprises a housing having a passageway therein through which air flow created by the ram effect is passed, and a flap which is mounted within the housing for limited pivotal movement and which extends into the passageway such that air flow impinging thereon produces displacement of the flap about its pivotal axis. A sensor senses a predetermined pivotal displacement of the flap, corresponding to a predetermined rate of ram air flow, and operates a switch to control energisation of the blower in accordance therewith.

Referring in particular to Figures 1 and 2, there is shown a fluid-flow sensing device which includes a housing 10. The housing 10 comprises two halves 11 and 12 moulded of plastics material, or, alternatively, diecastings, that are clamped together by three rivets 13 which extend through apertures 14 in the two halves 11 and 12. The halves 11 and 12 are provided with a tongue and a groove respectively (not shown in the drawings) on their abutting faces to ensure substantial alignment between the two halves 11 and 12 when they are clamped together.

The housing 10 defines a generally cylindrical compartment 15 which is divided by two radially-extending walls 21 and 22 of the housing to provide a passageway 16 and a substantially closed chamber 17. The passageway 16 communicates with an inlet port 19 and an outlet port 20 formed integrally on the housing 10 through which air is to be conveyed into and out of respectively the passageway 16.

A steel shaft 24 extends along the longitudinal axis of the compartment 15 and is mounted at its ends in recesses 25 and 26 in the halves 11 and 12 respectively of the housing 10. The surface of the shaft 24 together with an end face 27 of the wall 21 (shown in Figure 1) provide bearing surfaces for a steel flap 30 which extends from the chamber 17 into the passageway 16. The flap 30 is pivotally mounted about an axis which extends along the longitudinal axis of the cylindrical compartment 15 and which passes substantially through the centre of gravity of the flap 30. The flap 30 comprises a generally 'Z'-shaped member formed from a single steel sheet which is stamped to provide a recess 37 that partially surrounds the shaft 24 so as to permit pivotal movement of the flap 30 around the shaft 24. The flap 30 comprises two generally rectangular portions 33 and 34 which are disposed in the passageway 16 and the chamber 17 respectively and which are spaced from the side-walls of the housing 10 so as to permit air-flow therebetween. The two portions 33 and 34 are bent at their outer ends to form limbs 35 and 36 respectively which are curved to conform with peripheral surface of the compartment 15.

The air in the closed chamber 17 acts on the portion 34 to damp pivotal movement of the flap 30.

A helical spring 38 is retained in a recess 39 adjacent a wall 41 which extends across the cylindrical compartment 15, and acts between the housing 10 and a plunger 40 to urge the plunger 40 into engagement with the portion 33 of the flap 30. In this way, the flap 30 is urged towards a datum position in which the portion 34 of the flap 30 is in abutment with the wall 22 of the housing 10. The degree of pivotal movement of the flap 30 in a clockwise direction in Figure 1 is limited by abutment of the flap 30 with a part of the housing 10.

A reed-contact unit 42 and a magnet 43 are mounted in recesses 44 and 45 respectively in the housing 10 and are disposed on opposite sides of the path of travel of the limb 35 of the flap 30. The leads of the reed-

contact unit 42 are electrically connected to terminals 48, which are secured on the housing 10.

The fluid-flow sensing device shown in Figures 1 and 2 is mounted in a vehicle by means of bolts which pass through the apertures 14 in the housing 10, and the terminals 48 are connected to an electrical circuit which includes a power supply (such as the vehicle battery) and a relay which controls the energisation of the electric motor of the blower in the vehicle's ventilation system. The inlet port 19 of the device is coupled by a pipe (not shown) to a location on the vehicle which experiences ram air flow such that, upon movement of the vehicle, air is forced along the pipe and through the passageway 16 where it impinges upon the portion 33 of the flap 30. The flap 30 is pivoted by the impinging air, against the action of the spring 38, through an angle which is dependent upon the rate of flow of the impinging air. As the rate of air flow increases, the flap 30 is pivoted further clockwise in Figure 1. When the rate of air flow reaches a sufficiently large value, the limb 35 of the flap 30 passes between the reed-contact unit 42 and the magnet 43 so that the magnetic flux from the magnet is diverted through the steel flap 30, whereupon the contacts of the reed-contact unit 42 are opened and the associated relay operated to de-energise the blower.

The sensitivity of the fluid-flow sensing device may be adjusted by increasing or decreasing the pressure of the spring 38.

In practice, the contacts of the reed-contact unit assembly 42 are arranged to be opened by a ram air flow in accordance with a vehicle speed relative to the ground of, say, approximately forty miles per hour, although it will be appreciated that the device is responsive to a flow of air relative to the vehicle, and that headwinds or tailwinds will affect the switching speed. If the vehicle speed is gradually reduced, hysteresis in the reed-contact unit 42 and the limb 35 holds the contacts of the reed-contact unit 42 open until the vehicle speed is reduced to approximately twenty miles per hour, thereby eliminating erratic switching of the reed-contacts when the vehicle is cruising at around forty miles per hour.

It has been found that the provision in the fluid-flow sensing device of a balanced flap considerably improves the performance of the device over one which uses an unbalanced flap. By mounting the flap for pivotal movement about an axis which extends substantially through its centre of gravity, any effects on the flap as a result of acceleration and deceleration, whether longitudinally or otherwise of the vehicle in which the device is mounted are substantially avoided.

The two fluid-flow sensing devices shown in Figures 3 and 4, and Figures 5 and 6 respectively are generally similar in the device described with reference to Figures 1 and 2, and, accordingly the following descriptions will concern themselves primarily with modifications embodied in the two devices.

Referring now to Figures 3 and 4, there is shown a fluid-flow sensing device which includes a housing 60 formed from two halves 61 and 62 of plastics material. The halves 61 and 62 are secured together by means of two studs 64 formed integrally on each of the halves which project into respective apertures 15 in the other half of the housing 60 and which are deformed where they emerge from the apertures 65 so as to lock the two halves 61 and 62 together.

The housing 60 defines a generally cylindrical compartment 61 which is divided by walls 68 and 69 of the housing 60 to provide a passageway 66 and a substantially closed chamber 67. The housing 60 includes an inlet port 70 and an outlet port 71 which directly communicate with the passageway 64 for conveying air into and out of respectively the passageway 64.

A flap 75 of plastics material and having an integral spindle 76 is pivotally mounted within the housing 60 with the ends of its spindle 76 located in recesses 78 and 79 in the halves 60 and 61 respectively such that the spindle 76 extends along the longitudinal axis of the cylindrical compartment 63. Portions 80 and 81 of the flap 75 extend into the passageway 64 and the chamber 67 respectively. The portion 81 of the flap 75 is split at its end to form three resilient fingers 83, 84 and 85 which cooperate with one another to encircle partially and clamp therebetween a cylindrical bar magnet 86. The flap 75 is spaced slightly from the side walls of the housing 60 so as to permit the flow of air therebetween.

The spindle 76 of the flap 75, and therefore the pivotal axis of the flap 75, passes through the centre of gravity of the combination of the flap 75 and the bar magnet 86, the portion 81 having a counterweight 88 thereon for this purpose. In this way, the flap 75 is substantially balanced about its pivotal axis. Besides counterbalancing the flap 75, the portion 81 of the flap 75, being disposed in the closed chamber 67, also serves to damp pivotal movement of the flap 75.

The flap 75 is urged in an anti-clockwise direction in Figure 3 against a step 89 in the housing 60 by a conical spring 90 which, at its one end, extends around a stud 91 on the portion 80 on the flap 75 and, at its other end, bears against a portion of the housing 60. Pivotal movement of the flap 75 in the other sense is limited by a stop 92 formed on the housing 60.

A reed-contact unit 94 is mounted in the chamber 67 of the housing 60 and extends in

a direction parallel to the bar magnet 86. The leads 95 and 96 of the reed-contact unit 94 pass through a respective side wall of the housing 60 into recesses 98 and 99 where they are soldered to tabs on terminals 100 and 101 respectively, the recesses 98 and 99 subsequently being filled with insulating adhesive 97.

The terminals 100 and 101 extend through slots in the peripheral wall of the housing 60 on opposite sides of the reed-contact unit 94.

The housing 60 is formed with two apertures 103 through which bolts are passed in order to secure the device on a vehicle.

The device is coupled to a source of ram air-flow on the vehicle and to a relay which controls operation of the vehicle blower in an identical manner to that described with reference to the device shown in Figures 1 and 2.

In operation, the ram air flowing through the passageway 16 impinges on the portion 80 of the flap 75 and causes the flap 75 to pivot in a clockwise direction in Figure 3, against the action of the spring 90, by an amount which is dependent upon the rate of ram air flow. In doing so, the bar magnet 86 is moved away from the reed-contact unit 94. When the magnet 86 is moved a predetermined distance away from the reed-contact unit 94, which is indicative of a predetermined value of ram air flow, the contacts of the reed-contact unit 94 are opened, and the associated relay is operated to de-energise the blower motor.

A third form of fluid-flow sensing device is shown in Figures 5 and 6, and includes a housing 120 which is formed from halves 121 and 122 of plastics material. The housing 120 defines a generally cylindrical compartment 123 which is divided by walls 128 and 129 in the housing 120 into a passageway 124 and a substantially closed chamber 127. The housing 120 includes an inlet port 126 and an outlet port 131 which communicate with the passageway 124 to convey air into and out of the passageway 124 respectively.

Mounted within the interior compartment 123 and extending into both the passageway 124 and the chamber 127 is a flap 130 of plastics material. The flap 130 has integrally formed thereon two stub axles 132 and 133 which project into respective apertures 134 and 135 in the side walls of the housing 120 to permit pivotal movement of the flap 130 within the interior compartment 123 about an axis which extends along the longitudinal axis of the cylindrical compartment 123. The extent of pivotal movement of the flap 130 is limited by stops 136 and 137 formed integrally on the housing 120 in the passageway 124.

The flap 130 includes two portions 139 and 140 disposed in the passageway and 124 and the chamber 127 respectively. The portion 140 disposed in the chamber 127 is split at its end to form three resilient fingers 141, 142 and 143 which cooperate with one another to encircle partially and clamp therebetween a cylindrical bar magnet 144.

The flap 130 is mounted for pivotal movement about an axis which passes through the centre of gravity of the combination of the flap 130 and the magnet 144, and for this purpose a counterweight 145 is provided on the portion 139 of the flap 130. The portion 140 of the flap 130, besides counterbalancing the portion 139, also serves to damp pivotal movement of the flap 130 by reacting with the air inside the closed chamber 127.

The flap 130 is urged in an anti-clockwise direction in Figure 5 by a spiral spring 147 which is mounted outside the compartment 123 in a circular recess 148 in a side-wall of the housing 120. One end of the spiral spring 147 is located in a slot 149 in the stub axle 133, whilst the other end is attached to a point on the wall of the recess 148. The recess 148 is closed by a disc-shaped cover 150 which is retained in position by resilient projections 151 on the wall of the recess 148.

A reed-contact unit 152 is mounted on the internal peripheral wall of the chamber 127 with its leads 153 and 154 extending through a respective side wall of the housing 120. The leads 153 and 154 are electrically connected to a respective spade terminal 155 and 156, each of which extends through the housing 120 into the chamber 127 where it is bent over to retain it in position. As can be seen in Figure 5, the lead 154 extends into a recess 157 in the housing 120 where it is soldered to a portion of the terminal 155, the recess subsequently being filled with insulating adhesive 158. A similar connection (not visible in Figure 5) is made between the lead 153 and the terminal 156.

The two halves 121 and 122 of the housing 120 are secured together by means of four studs 160, two on each of the halves 121 and 122, which extend from their respective half into apertures 161 in the other half of the housing. Each of the studs 160 is slotted at 162 and has a shoulder 163 which is outwardly spring when the stud 160 is in position to lock behind a cooperating flange 164 of the aperture 161.

Further apertures 166 are provided in the housing 120 for the purpose of mounting the air flow sensing device in position on a vehicle.

When disposed in a vehicle, and coupled to a source of ram air flow in the vehicle and a relay for controlling operation of a blower, in a similar manner to that previously described, operation of the air flow sensing device shown in Figures 5 and 6 is similar to those described with reference to Figures 1 and 2 in that ram air flow is transmitted

through a pipe from a suitable location on the vehicle into the passageway 124 through the inlet port 126 where it impinges on the portion 139 of the flap 130 and causes the flap 130 to pivot clockwise in Figure 5 against the action of the spiral spring 147. In doing so, the flap 130 carries the magnet 144 away from the reed-contact unit 152 such that, when the magnet 144 has moved a predetermined distance away from the reed-switch 152, corresponding to a predetermined value of ram air flow, the contacts of the reed-contact unit 152 spring open and operate a relay to de-energise the vehicle's blower.

The amount by which the flap 130 pivots in response to ram air flow can be adjusted in the device shown in Figure 5 by re-positioning the end of the spiral spring 147 on the wall of the recess 148 of the housing 120 which is provided with a plurality of suitable attachment points for this purpose.

It is envisaged that the reed-contact unit 42, 94 and 152 of the described devices may be replaced by any suitable magnetically-operable switching device such as, for example, a Hall-effect switching device.

WHAT WE CLAIM IS:–

1. A fluid-flow sensing device including a housing defining a fluid flow passage, a member pivotally mounted in the housing for a limited degree of angular displacement about its pivotal axis in response to fluid flow through the said passage with the extent of each angular displacement varying in accordance with rate of said fluid flow, and means which is arranged to sense a predetermined displacement of said member about its pivotal axis, wherein the said pivotal axis of the member extends substantially through the centre of gravity of that member, and wherein the device includes means to damp said pivotal displacement of the said member.

2. A fluid-flow sensing device according to Claim 1, including resilient means that is arranged to urge the member towards a datum position.

3. A fluid-flow sensing device according to Claim 2, wherein said resilient means comprises spring means.

4. A fluid-flow sensing device according to any one of the preceding claims, wherein said damping means comprises a substantially closed chamber into which the said member extends.

5. A fluid-flow sensing device according to Claim 4, wherein the said member comprises a flap having a portion to one side of the pivotal axis which extends into the said passageway and a portion to the other side of the pivotal axis which extends into the said chamber.

6. A fluid-flow sensing device according to any one of the preceding claims, wherein the said sensing means comprises a magnet and a magnetically-operable switching device.

7. A fluid-flow sensing device according to Claim 6, wherein the magnet and the switching device are mounted on opposite sides of the path of travel of a part of the said member so that, upon the predetermined pivotal displacement of said member being attained, magnetic flux is diverted through said part to change the state of the switching device.

8. A fluid-flow sensing device according to Claim 7, wherein the magnet and the switching device are mounted within said housing.

9. A fluid-flow sensing device according to Claim 6, wherein the said member includes the magnet and the switching device is mounted on the housing so that, upon the predetermined pivotal displacement of the said member being attained, the magnet is moved a sufficient distance relative to the switching device to change the state of the switching device.

10. A fluid-flow sensing device according to any one of Claims 6 to 9, wherein the magnetically-operable switching device comprises a reed-contact unit.

11. A fluid-flow sensing device substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

12. A fluid-flow sensing device substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

13. A fluid-flow sensing device substantially as hereinbefore described with reference to Figures 5 and 6 of the accompanying drawings.

14. Apparatus for controlling the operation of a blower in a vehicle ventilation system comprising a fluid-flow sensing device as claimed in any one of the preceding claims, means for coupling the said passageway of the device to a source of ram air flow on the vehicle, and means for controlling a said blower in accordance with the fluid flow sensed by the said device to inhibit operation of the blower wherever the pivotal displacement of the said member attains the said predetermined value.

15. A vehicle ventilation system comprising a blower for supplying air to the interior of the vehicle, and control apparatus as caimed in Claim 14 for controlling the operation of the said blower.

16. A vehicle incorporating a vehicle ventilation system as claimed in Claim 15.

For the Applicants
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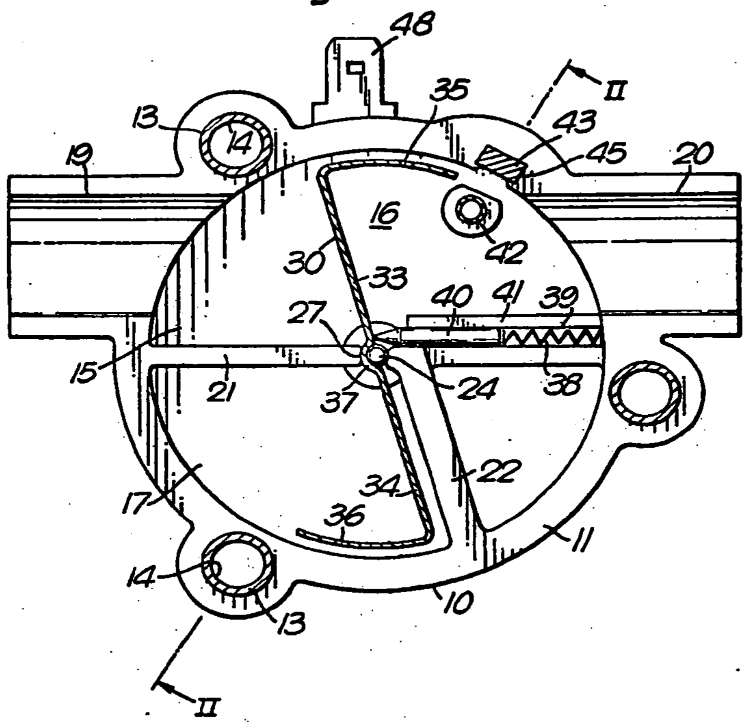
Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1981. Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

Fig.1.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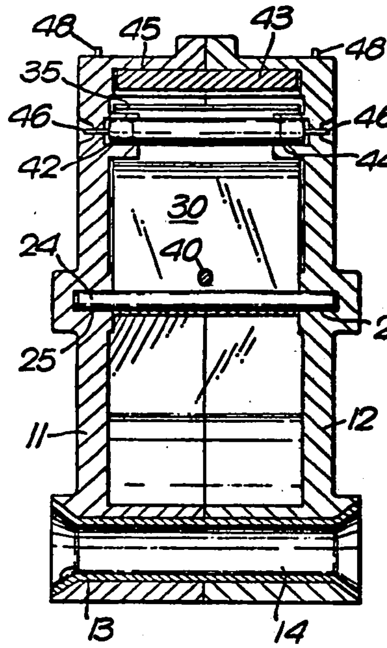
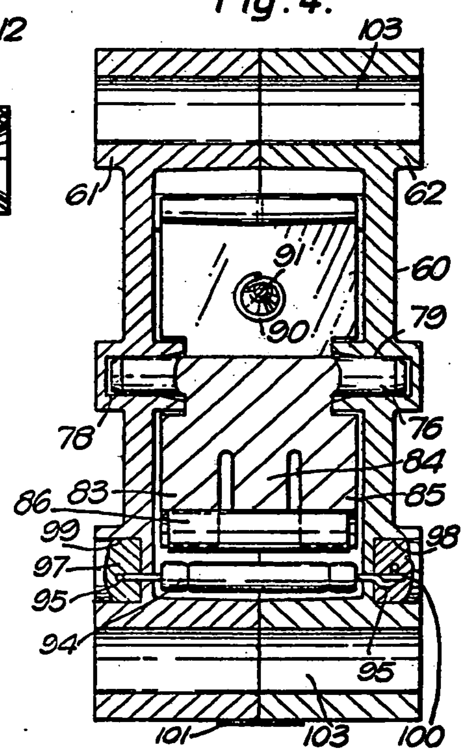


Fig. 2.

Fig. 4.



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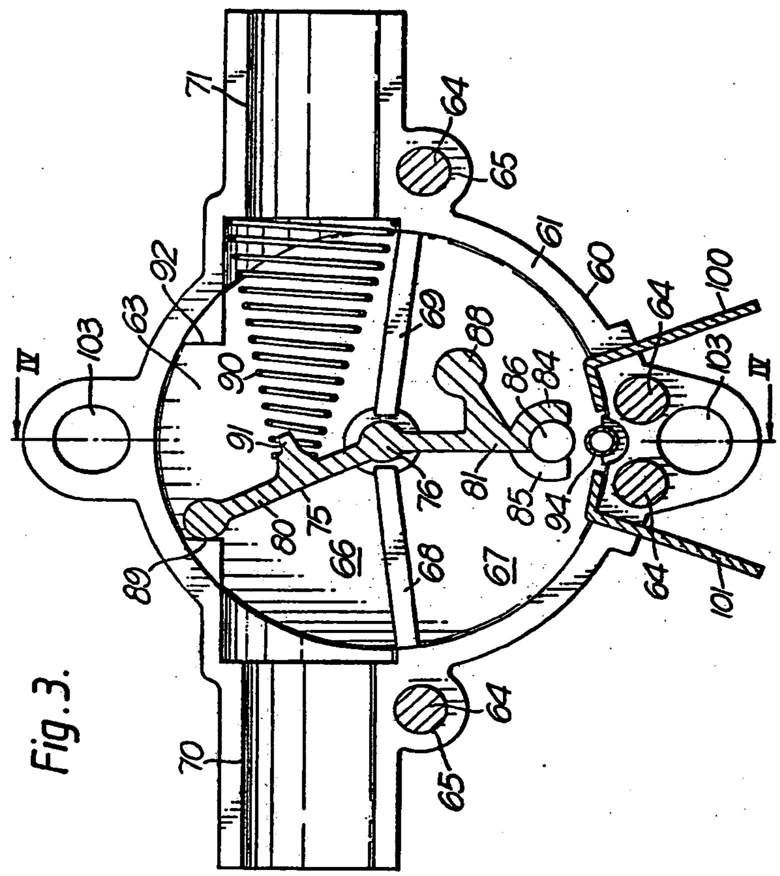

Fig.3.

Fig. 5.

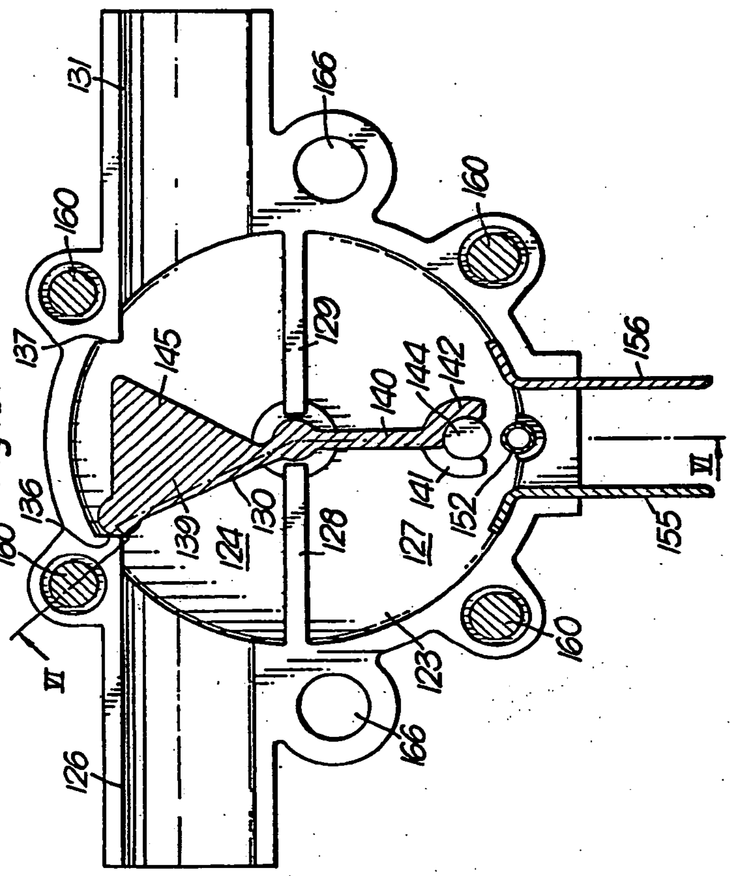
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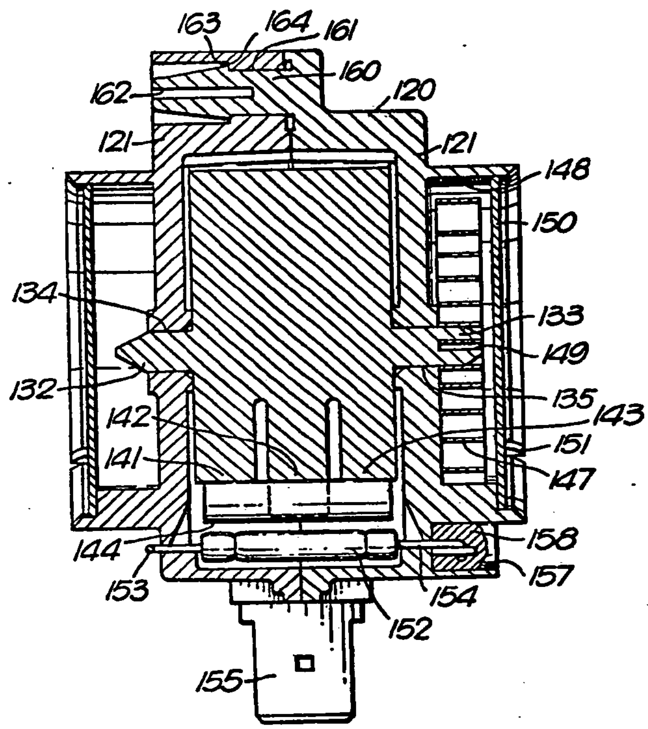
Fig. 6.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